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(54) Abstract Title
Transceiver with bidirectional internal interface lines

(57) A transceiver includes bidirectional internal interface lines 24, 25, 26, 27, that can be connected between a transceiver package 1 and an integrated circuit 36. The transceiver package comprises quadrature modulation device 3 and quadrature demodulation device 2. The IC comprises baseband circuitry 39, analog to digital converter 37 and digital to analog convertor 38. The transceiver may be switched between a transmit and receive mode by the baseband circuit via control line 71 such that: in a transmit mode the modulation device 3 is connected to the IC by the interface lines; and in a receive mode demodulation device 2 is connected. The use of bidirectional interface lines reduces interference and aids miniaturisation as four interface lines are required instead of eight.

FIG 2

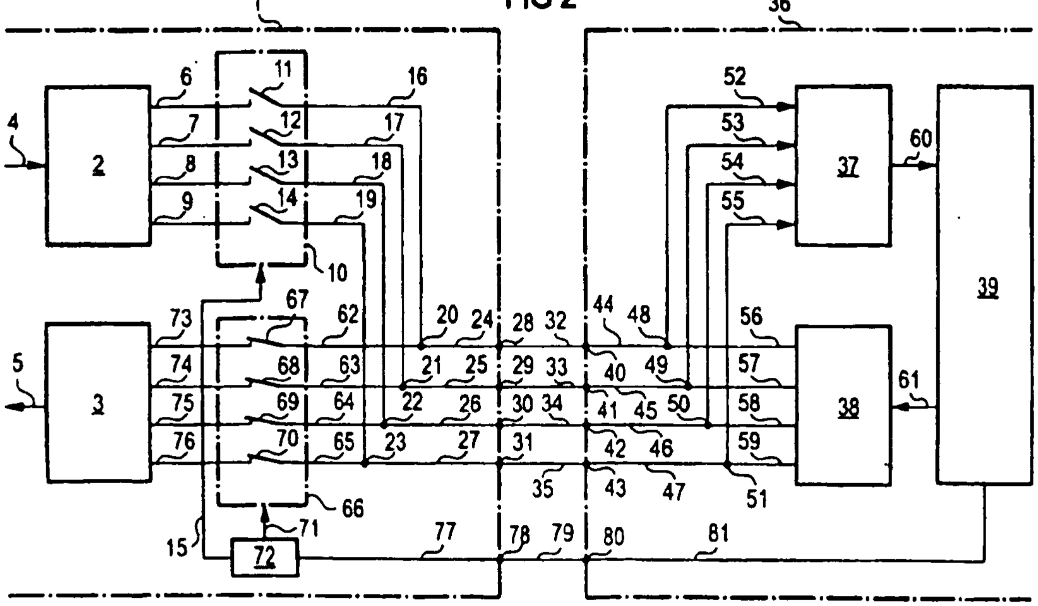

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FIG 1

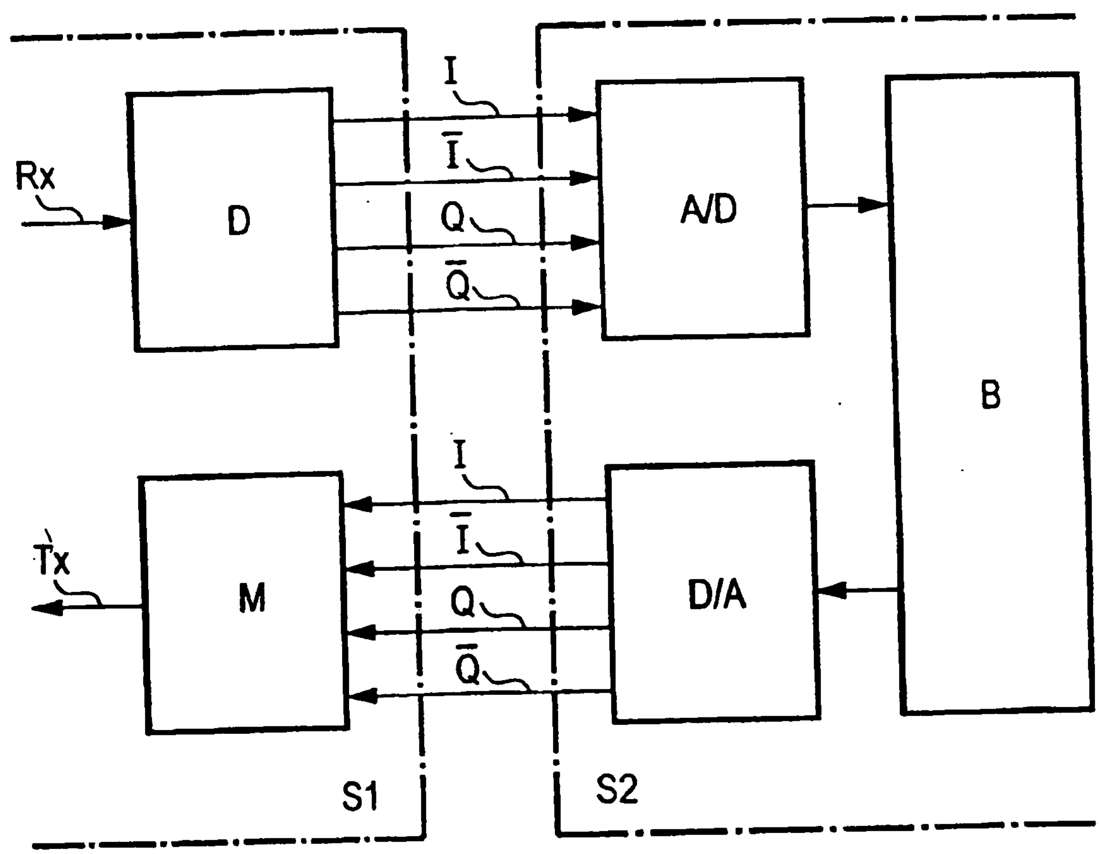
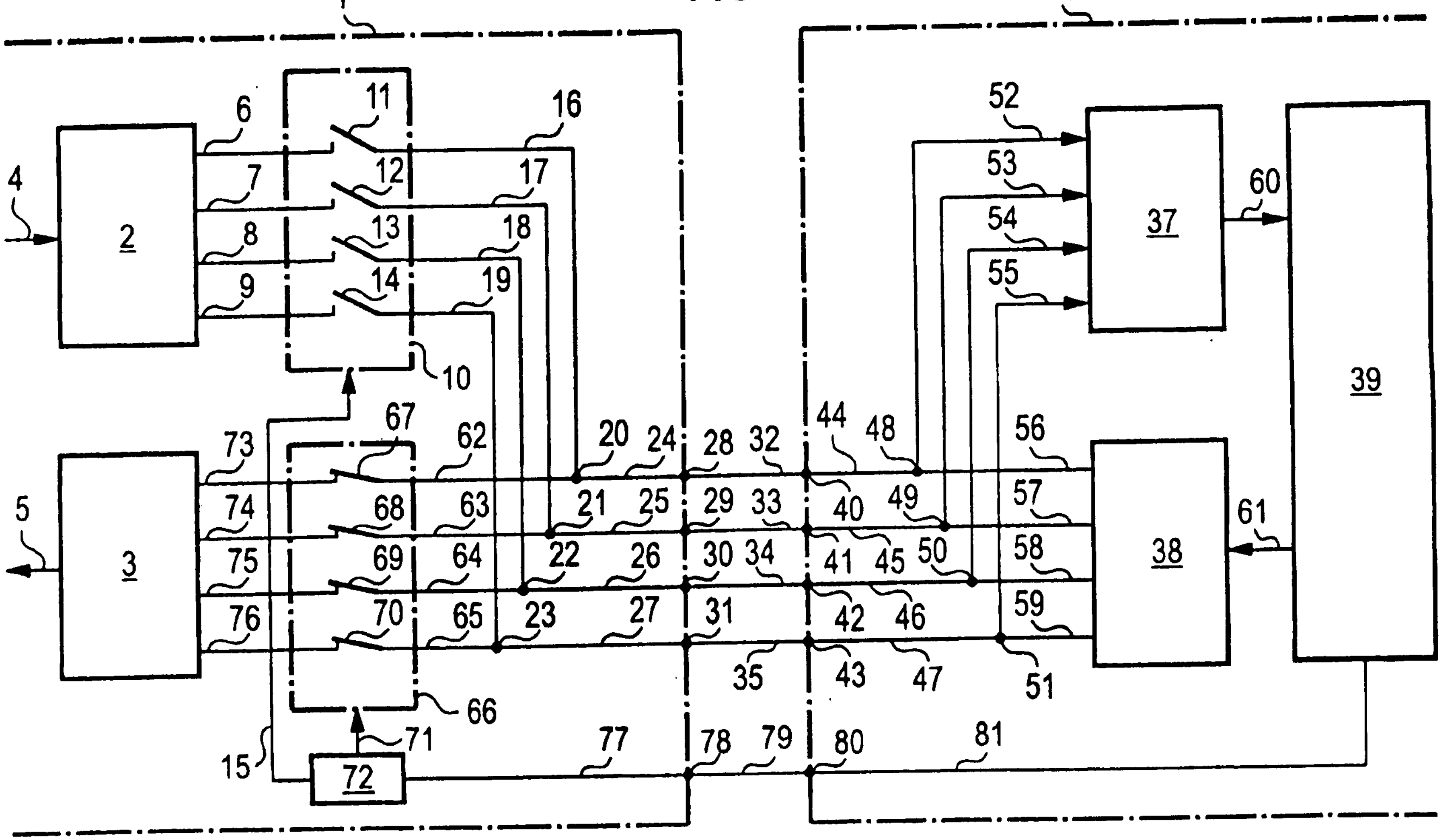


FIG 2



TRANSCEIVERS

The invention relates to transceivers and in particular to transceivers that can be connected via bidirectional internal interface lines to a baseband circuit of a mobile radio telephone.

Some cellular mobile radio networks operate according to the GSM standard, wherein useful data are transmitted within time slots in a time division multiple access (TDMA) mode. Conventional mobile radio telephones have a modulation device for transmitting data and a demodulation device for receiving data.

DE 197 19 658 A1 shows a transceiver for high-frequency signals, that has a baseband circuit which in the receive mode is fed by a demodulator and in the transmit mode feeds a quadrature modulator. A changeover switch for switching between the transmit and receive path is provided at the antenna.

DE 195 28 069 C2 shows a radio set with a signal processor. In the receive mode the signal processor is fed by a demodulator. In the transmit mode the signal processor feeds a modulator. A controller is used to actuate an antenna changeover switch so that, depending on the operating mode, either the receive path is activated via the demodulator or the transmit path is activated via the modulator. The control signals delivered by the controller are also fed to the demodulator and to the modulator.

Fig. 1 of the accompanying drawings shows the construction of a conventional mobile radio telephone according to the prior art. Via a receive line RX a demodulator D receives receive data that are fed to an

analogue/digital converter A/D via an in-phase line I, an inverted in-phase line $\overline{I}$, a quadrature phase line Q and an inverted quadrature phase line $\overline{Q}$. The A/D converter converts the analogue signals into digital data and delivers them to the digital baseband circuit B of the mobile radio telephone. Conversely, in the transmit mode the digital baseband circuit delivers the data to a digital/analogue converter D/A which converts the digital data into analogue signals and passes them to a modulation device M via an in-phase line I, an inverted in-phase line $\overline{I}$, a quadrature phase line Q and an inverted quadrature phase line $\overline{Q}$. The modulation device M generates a modulated transmit signal according to the received analogue signals and delivers this via a transmit line TX.

In conventional mobile radio telephones the modulation device M and the demodulation device D are integrated in a circuit S1, while the baseband circuit B with the analogue/digital converters and the digital/analogue converters is integrated in a circuit S2. As can be seen from Fig. 1, both the integrated circuits S1, S2 are connected via a total of eight interface lines when a quadrature modulation method is used as in GSM.

In addition to the demodulation device D and the modulation device M, the integrated transmit and receive circuit S1 has a number of further components (not shown) which are required for the transmit and receive modes. These components are, for example, PLL circuits, voltage-controlled oscillators and voltage-regulating switching devices. These components are connected on the one hand to the baseband circuit of the mobile radio telephone and on the other hand to the transmitting stage and the receiving stage via a number of control lines (not shown). Furthermore, the

integrated circuit S1 requires package leads or pins for connection to the supply voltage and to ground. However, because of the desired miniaturisation, the number of available package pins in the integrated circuit S1 is limited. In the case of conventional transceivers for mobile radio telephones, due to the inadequate number of available package pins, desired ground connections are dispensed with, which leads to a degradation of the operating characteristics.

A further disadvantage of transceivers in conventional mobile radio telephones is that the large number of interface lines to the baseband circuit leads to a high susceptibility to interference, since the useful data are transmitted on these lines and are easily corrupted by external influences. These interface lines therefore have to be expensively screened and protected against interference with the aid of capacitors. This leads on the one hand to increased costs during production and at the same time reduces further miniaturisation of the mobile radio telephone.

The object of this invention is therefore to create a transceiver which can be connected to a baseband circuit of a mobile radio telephone with the fewest possible interface lines.

This object can be achieved according to the invention by a transceiver having the features stated in Claim 1 of the accompanying claims.

Further advantageous developments of a transceiver according to the invention are stated in the sub-claims.

One such transceiver according to the invention has

bidirectional internal interface lines which can be connected to a baseband circuit of a mobile radio telephone, wherein the transceiver can be switched by the baseband circuit between a transmit and a receive mode and has at least one quadrature modulation device that in the transmit mode is connected via transmit lines to the interface lines and at least one quadrature demodulation device that in the receive mode is connected via receive lines to the interface lines.

In an advantageous development of the transceiver according to the invention, in the transmit mode the quadrature demodulation device is switched in the high-resistance state and in the receive mode the quadrature modulation device is switched in the high-resistance state.

This offers the particular advantage that the interface lines can be operated in both directions, without the frequency response of the quadrature demodulation device in the receive mode being affected by the quadrature modulation device and conversely in the transmit mode the frequency response of the quadrature modulation device is not influenced by the quadrature demodulation device.

In a further advantageous development of the transceiver according to the invention the quadrature modulation device and the quadrature demodulation device are completely electronically decoupled.

In a further preferred development of the transceiver according to the invention the transmit and receive lines can be switched via multiplex switching devices.

This offers the particular advantage that the switching

between transmit and receive modes is rapidly and reliably ensured with a small amount of circuitry.

In a further advantageous development of the transceiver according to the invention, said transceiver has an internal control circuit for activating the multiplex switching devices, wherein the multiplex switching devices are connected to the multiplex control circuit via internal control lines.

In a further advantageous development of the transceiver according to the invention the control circuit for activating the multiplex switching devices can be connected to the baseband circuit of the mobile radio telephone via a control line.

This offers the particular advantage that the changeover between transmit mode and receive mode can be controlled via a single control line, so that only one package pin of the transceiver is required for this.

In a further advantageous development of the transceiver according to the invention each of the transmit and receive lines includes in-phase and quadrature phase lines.

In a further advantageous development of the transceiver according to the invention each of the transmit and receive lines includes an in-phase line, an inverted in-phase line, a quadrature phase line and an inverted quadrature phase line.

In a further advantageous development of the transceiver according to the invention this contains at least one GMSK modulation device and one GMSK

demodulation device.

In a further advantageous development of the transceiver according to the invention this contains at least one QAM modulation device and one QAM demodulation device.

In a further advantageous development of the transceiver according to the invention this contains at least one PSK modulation device and at least one PSK demodulation device.

In a further advantageous development of the transceiver according to the invention each of the transmit and receive modes is maintained at least for the duration of one time slot of each TDMA data channel access.

In a further advantageous development of the transceiver according to the invention this is used as a transmitting and receiving device for the baseband circuit of a mobile radio telephone.

Reference will now be made, by way of example only, to the accompanying drawings, in which:

Fig. 1 is a block diagram showing the connection of a conventional transceiver to a baseband circuit;

Fig. 2 is a block diagram showing a transceiver according to the invention connected to a baseband circuit of a mobile radio telephone.

With reference to Fig. 2, a transceiver according to the invention is integrated into a package 1. The transceiver contains a quadrature demodulation device 2

and a quadrature modulation device 3. The quadrature demodulation device 2 is connected via a receive line 4 to a high-frequency receiving stage (not shown). The quadrature modulation device 3 is connected via a transmit line 5 to a high-frequency transmitting stage (not shown). In the receive mode in this case the quadrature demodulation device receives a message receive signal via an antenna and the high-frequency stage. In the transmit mode the modulation device 3 transmits a message transmit signal via the transmit line 5, the high-frequency stage and the antenna. The quadrature modulation device 3 and the quadrature demodulation device 2 are operated in a TDMA time-division multiplex process conforming to the GSM standard. In this case they can preferably transmit signals in the GSM 900, GSM 1800 and GSM 1900 frequency bands. The quadrature demodulation device 2 and the quadrature modulation device 3 facilitate phase and amplitude modulation. Any modulation method can therefore be employed in which the amplitude, the phase, as well as the amplitude and the phase are modulated simultaneously, such as for example GMSK modulation, MSK modulation and QAM modulation.

The quadrature demodulation device 2 is connected to a first multiplex switching circuit 10 via an in-phase signal line 6, an inverted in-phase line 7, a quadrature signal line 8 and an inverted quadrature signal line 9. The multiplex switching device 10 has internal switches 11, 12, 13, 14, which can be changed over simultaneously via a control line 15 from a first output state to a second output state. In the closed state, the switches 11, 12, 13, 14 pass the analogue receive signals appearing on the lines 6, 7, 8, 9 via lines 16, 17, 18, 19 and via internal nodes 20, 21, 22, 23 to internal bidirectional interface lines 24, 25,

26, 27. The switched-through received analogue signals pass via the bidirectional internal interface lines 24, 25, 26, 27 to the package pins 28, 29, 30, 31 on the package 1 of the transceiver according to the invention. The received analogue receive signals are transmitted via bidirectional external interface lines 32, 33, 34, 35 from the package 1 of the transceiver according to the invention to a further integrated circuit 36. The integrated circuit 36 contains an analogue/digital converter 37, a digital/analogue converter 38 and a baseband circuit 39 for a mobile radio telephone. A speech microphone (not shown) and a loudspeaker (not shown) can be connected to the baseband circuit 39. The integrated circuit 36 has package pins 40, 41, 42, 43 for connection to the package pins 28, 29, 30, 31 of the transceiver 1 according to the invention via the external bidirectional interface lines 32, 33, 34, 35. The package pins 40, 41, 42, 43 of the integrated circuit 36 are led via internal bidirectional interface lines 44, 45, 46, 47 to branch points 48, 49, 50, 51 at which they branch into receive lines 52, 53, 54, 55 and transmit lines 56, 57, 58, 59. The receive lines 52, 53, 54, 55 are routed to the analogue/digital converter 37, which converts the received analogue signals into digital signals and delivers these via lines 60 to the baseband circuit 39.

In the transmit mode, the baseband circuit 39 delivers digital transmit signals via lines 61 to the digital/analogue converter 38, which converts the digital transmit signals into analogue transmit signals. The analogue transmit signals pass via the internal transmit lines 56, 57, 58, 59 and the internal bidirectional interface lines 44, 45, 46, 47 to the package pins 40, 41, 42, 43 of the integrated circuit

36. From there, they are applied via the bidirectional external interface lines 32, 33, 34, 35 to the package pins 28, 29, 30, 31 of the package 1 in which the transceiver according to the invention is located. Furthermore, the analogue transmit signals are applied via the internal bidirectional interface lines 24, 25, 26, 27 of the transceiver according to the invention to the internal transmit signal lines 62, 63, 64, 65, which can be switched via a second multiplex switching device 66. The second multiplex switching device 66 has four internal switches 67, 68, 69, 70. These internal switches 67, 68, 69, 70 can be switched by an internal control line 71 which connects the second multiplex switching device 66 of the transceiver according to the invention to an internal control circuit 72. If the switches 67, 68, 69, 70 of the second multiplex switching device 66 are closed, as shown in Fig. 2, the quadrature modulation device 3 receives the analogue transmit signals via internal lines 73, 74, 75, 76.

The internal control circuit 72 for switching the multiplex switching devices 10, 66, that is provided in the package 1 of the transceiver according to the invention, is connected via an internal control line 77 to a package pin 78 that is connected via an external control line 79 to a package pin 80 of the integrated circuit 36. The baseband circuit 39 delivers a control signal to the switching control device 72 via an internal control line 81 of the second integrated circuit 36 and via the lines 80, 77.

In the transmit mode, the baseband circuit 39 controls the internal control circuit 72 of the transceiver according to the invention so that said internal control circuit opens the internal switches 11, 12, 13, 14 of the multiplex switching device 10 and closes the

internal switches 67, 68, 69, 70 of the second multiplex switching device 66 via the control lines 15, 71, respectively. Conversely, in the receive mode, the baseband circuit 39 controls the internal control circuit 72 of the transceiver according to the invention so that said internal control circuit closes the internal switches 11, 12, 13, 14 of the first multiplex switching device 10 and opens the internal switches 67, 68, 69, 70 of the second multiplex switching device 66 via the control lines 15, 71, respectively.

In a preferred embodiment (not shown), the switching is effected not by additional multiplex switching devices 10, 66 but by directly switching the quadrature modulation device 3 and the quadrature demodulation device 2. On this occasion, in the receive mode, the quadrature modulation device 3 is switched in the high resistance state, so that the quadrature modulation device does not affect the frequency response of the quadrature demodulation device on receipt of the message transmit signals. Conversely, in the transmit mode, the quadrature demodulation device 2 is switched in the high-resistance state so that this does not affect the frequency response of the quadrature modulation device 3. In this case the quadrature modulation device 3 and the quadrature demodulation device 2 are preferably fully electrically decoupled.

In a further preferred embodiment of the transceiver according to the invention, the control of the switching between transmit and receive modes is not effected via a separate special control line as shown in Fig. 2, but via the interface lines between the integrated circuit 36 and the transceiver 1 according to the invention.

As can be immediately seen by comparing the conventional arrangement illustrated in Fig. 1 with the arrangement according to the invention illustrated in Fig. 2, the number of necessary interface lines between the integrated circuit 36, in which the baseband circuit of the mobile radio telephone is located, and the transceiver 1 according to the invention is considerably reduced, that is to say halved. This is achieved in that the transceiver according to the invention has internal interface lines 24, 25, 26, 27, which are used bidirectionally in the transmit and receive modes. As a result, in the exemplary embodiment shown in Fig. 2, only four package pins 28, 29, 30, 31 are reserved for the message data transmission. The package pins which become free as a result of this can be used for other functions, for example for earthing internal components of the transceiver. This considerably improves the operating characteristics of the transceiver. Moreover, only four external interface lines 32, 33, 34, 35 have to be screened against electromagnetic or mechanical disturbances, which reduces costs and facilitates further miniaturisation. Also, the number of decoupling capacitors normally connected to the external interface lines for reducing electromagnetic interference is reduced in the transceiver according to the invention, since in the embodiment illustrated in Fig. 2, only four decoupling capacitors are needed compared to eight decoupling capacitors, for example, in the conventional arrangement shown in Fig. 1. Here the space saving is considerable, in particular in the application in mobile radio telephones.

The internal interface lines 24, 25, 26, 27 of the transceiver according to the invention can be used bidirectionally since mobile radio transceivers always

operate in the semi-duplex mode, that is to say one time slot is always used either for transmitting or for receiving data. In the transceiver according to the invention the semi-duplex mode specified by the GSM standard is utilised in order to halve the number of package pins needed for message transmission, which on the one hand results in a saving in costs and space and on the other hand also further reduces the susceptibility to interference.

List of reference numbers

1	Transceiver package
2	Quadrature demodulation device
3	Quadrature modulation device
4	Receive line
5	Signal line
6, 7, 8, 9	Internal receive lines
11, 12, 13, 14	Internal switches
15	Internal control line
16, 17, 18, 19	Internal receive lines
20, 21, 22, 23	Internal nodes
24, 25, 26, 27	Internal interface lines
28, 29, 30, 31	Package pins
32, 33, 24, 25	External interface lines
36	Integrated circuit
37	Analogue/digital converter
38	Digital/analogue converter
39	Baseband circuit
40, 41, 42, 43	Package pins
44, 45, 46, 47	Interface lines
48, 49, 50, 51	Nodes
52, 53, 54, 55	Receive lines
56, 57, 58, 59	Transmit lines
60	Receive lines

61	Transmit lines
62, 63, 64, 65	Internal receive lines
66	Multiplex switching device
67, 68, 69, 70	Internal switches
71	Control line
72	Control line
73, 74, 75, 76	Internal transmit lines
77	Internal control line
78	Control line package pin
79	External control line
80	Control line package pin

Claims

1. A transceiver comprising internal interface lines (24, 25, 26, 27), that can be connected to a baseband circuit, a quadrature modulation device (3) and a quadrature demodulation device (2), the transceiver being switchable between a transmit mode and a receive mode characterised in that the internal interface lines (24, 25, 26, 27) are bidirectional, in that the quadrature modulation device (3) is connected, in the transmit mode of the transceiver, to the internal interface lines (24, 25, 26, 27) and in that the quadrature demodulation device (2) is connected, in the receive mode of the transceiver, to the internal interface lines (24, 25, 26, 27).

2. A transceiver as claimed in Claim 1, characterised in that the quadrature demodulation device (2) is operable to be switched into a high-resistance state in the transmit mode and the quadrature modulation device (3) is operable to be switched into a high-resistance state in the receive mode.

3. A transceiver as claimed in Claim 1 or 2, characterised in that the quadrature modulation device (3) and the quadrature demodulation device (2) are decoupled.

4. A transceiver as claimed in any one of Claims 1 to 3, characterised by multiplex switching devices (10, 66) which are provided for switching the quadrature demodulation device (2) and the quadrature modulation device (3) to the internal interface lines (24, 25, 26, 27).

5. A transceiver as claimed in Claim 4, characterised

by a multiplex control circuit (72) that is connected to the multiplex switching devices (10, 66) via internal control lines (15, 71).

6. A transceiver as claimed in Claim 5, characterised in that the multiplex control circuit (72) can be connected to the baseband circuit (39) via a control line.

7. A transceiver as claimed in any one of Claims 1 to 6, comprising transmit and receive lines each of which includes in-phase and quadrature phase lines.

8. A transceiver as claimed in any one of Claims 1 to 6, comprising transmit and receive lines each of which includes an in-phase line, an inverted in-phase line, a quadrature phase line and an inverted quadrature phase line.

9. A transceiver as claimed in any one of Claims 1 to 8, characterised in that it contains a GMSK modulation device and a GMSK demodulation device.

10. A transceiver as claimed in any one of Claims 1 to 8, characterised in that it contains a QAM modulation device and a QAM demodulation device.

11. A transceiver as claimed in any one of Claims 1 to 8, characterised in that it contains a PSK modulation device and a PSK demodulation device.

12. A transceiver as claimed in any one of Claims 1 to 11, characterised in that each of the transmit and receive modes is maintained at least for the duration of one time slot of each TDMA data channel access.

Application No:	GB 0009229.6	**Examiner:**	Robert Macdonald
Claims searched:	1-13	**Date of search:**	24 May 2000

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): H4L(LECSV, LECSX, LEQF, LECY)

Int Cl (Ed.7): H04B(1/707, 1/38, 1/40, 1/44, 1/46, 1/48)

Other: ONLINE: WPI, PAJ, EPODOC, INSPEC

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	EP 0866588 A (HARRIS CORP) See whole document	
A	D. Sallaerts et al, "1990 IEEE International Solid-state circuits conference - digest of technical papers" published 1990, IEEE, pp 34-35, "A 270kbit/s 35mW Modulator IC for GSM Cellular Radio Hand-held Terminals".	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
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